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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/388,826	09/01/1999	WEIMIN LI	MI22-1208	4483
21567	7590	02/02/2004	EXAMINER	
WELLS ST. JOHN P.S. 601 W. FIRST AVENUE, SUITE 1300 SPOKANE, WA 99201			KIELIN, ERIK J	
			ART UNIT	PAPER NUMBER
			2813	

DATE MAILED: 02/02/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/388,826

Applicant(s)

LI ET AL.

Examiner

Erik Kielin

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 30 September 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 102-124, 126-131 and 133-139 is/are pending in the application.
- 4a) Of the above claim(s) 113, 114 and 135-139 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 102-112, 115-124, 126-131, 133 and 134 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. §§ 119 and 120

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 13) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.
a) ☐ The translation of the foreign language provisional application has been received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) all. 6) ☐ Other: _____

DETAILED ACTION

This action responds to the Amendment filed 30 September 2003.

Election/Restrictions

1. Newly submitted claims 113, 114, 136-139 are directed to an invention that is independent or distinct from the invention originally claimed for the following reasons: Applicant admits in the response at p. 14 that the subject matter of claims 113 and 114 have been incorporated into claim 102. Yet claims 113 and 114 have been amended to include specific parameters of the plasma exposure, not previously provided in any claim. These parameters generate new species of the instant method and are new claims by Applicant's admission. New claims 136-139 also introduce specific plasma parameters not formerly introduced.

Since applicant has received an action on the merits for the originally presented invention, this invention has been constructively elected by original presentation for prosecution on the merits. Accordingly, claims 113 and 114 are withdrawn from consideration as being directed to a non-elected invention. See 37 CFR 1.142(b) and MPEP § 821.03. The aforementioned claims may be entitled to rejoinder upon the allowance of a claim from which the new claims depend.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

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3. Claims 102-112, 115-124, 126-128, and 129-131, 133, 134 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

Claims 102-112, 115-124, 126-128, and 129-131, 133, 134 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

Regarding independent claims 102 and 129, the instant specification indicates that the blanket exposing to form the $(\text{CH}_3)_x\text{SiO}_y$ layer from the non-descript first layer of Si bonded to methyl groups without oxygen, is a separate step from the blanket exposing of the $(\text{CH}_3)_x\text{SiO}_y$ layer to reduce its dielectric constant. As presently written, the claim appears to require the conversion to $(\text{CH}_3)_x\text{SiO}_y$ and the reduction of its dielectric constant appear to happen simultaneously or with a single plasma oxygen exposure. There is no support in the specification for the conversion to $(\text{CH}_3)_x\text{SiO}_y$ and reduction of the dielectric constant of $(\text{CH}_3)_x\text{SiO}_y$ to occur with the same oxygen plasma exposure. Accordingly, this is not enabled and is new matter.

The specification proves that the plasma exposure to convert the non-descript "first layer" of methyl groups bonded to silicon atoms without oxygen to $(\text{CH}_3)_x\text{SiO}_y$ are different from the oxygen plasma exposure used to reduce the dielectric constant. In the paragraph bridging pages 9 to 10, the oxygen exposure for converting the non-descript "first layer" to $(\text{CH}_3)_x\text{SiO}_y$ is

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characterized as being performed by “plasma, heat or ultra-violet light” in the presence of some oxygen-containing moiety, for example O₂ or N₂O. No plasma is required and no plasma conditions are provided. By contrast, in the paragraph bridging pp. 11 and 12, the oxygen exposure to reduce the dielectric constant must specifically be a plasma. Nowhere in the specification is the plasma for reducing the dielectric constant characterized as being the same as that for converting the non-descript first layer into (CH₃)_xSiO_y. This is new matter. This further makes non-elected claims 113 and 114, which add the dielectric constant-reducing plasma parameters as those used for the conversion step, not enabled, since these plasma parameters used for reducing the dielectric constant are **nowhere** indicated in the specification to be also used for the conversion step.

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claims **102**-112, 115-124, 126-128, and **129**-131, 133, 134 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Regarding independent claims 102 and 1289, as presently written the terminology “effective to...” is indefinite for failing to positively recite whether or not the step is actually carried out. For example, simply because the oxygen-comprising plasma is “**effective** to reduce the dielectric constant to a second dielectric constant” is not a positive requirement for the reduction of the dielectric constant to occur. Instead it is merely an observation that the oxygen plasma is capable of performing the reduction, whether or not it occurs.

The claims will be interpreted as best understood and as broadly interpreted, meaning that the steps are not necessarily performed.

The remaining claims are rejected for depending from the above rejected claims.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

7. Claims **102-110, 112-124, 126-128 and 129-131, 133, 134** are rejected under 35 U.S.C. 103(a) as unpatentable over **Yau et al.** (US 6,072,227) in view of **Morita** (JP 63-157443 A).

Regarding claims 102 and 129, **Yau** discloses the substrate **512** (Fig. 8A) having at least partially formed integrated circuitry formed thereon; depositing thereon a low k dielectric layer **510, 518**, (which may be a liner layer, cap layer, intermetal dielectric layer, or etch stop layer; [Abstract]) using a PECVD method with precursors of, for example, methylsilane and an oxygen containing gas, such as O₂ or N₂O (col. 5, lines 35-37). Note that the dielectric layer is porous (col. 3, lines 13-29) and has a dielectric constant of less than 3.0 (**Yau**, claim 13) and in one example, a dielectric constant of 2.5 (col. 15, lines 5-18). The layer has from 1% to 50 % carbon from Si-CH₃ bonds. (See also, col. 12, line 41 to col. 13, line 52.)

Yau does not teach plasma treating the dielectric layer with oxygen plasma.

Morita discloses a very similar method to **Yau** comprising forming a low-dielectric-constant material comprising phenyl or alkyl silicon oxide **10** which inherently has a dielectric constant of less than 3.5 over an integrated circuit Fig. 2; blanket exposing the dielectric to oxygen plasma to form an upper surface **11** of silicon oxide which is inherently effective to reduce the dielectric constant. (See Figs. 1-2; page 2, lower two columns.) Note that a whole of the dielectric layer is not converted from one base to another (Applicant's claim 19) and that the $(\text{CH}_3)_x\text{SiO}_y$ remains as $(\text{CH}_3)_x\text{SiO}_y$. Moreover, claim 129 only requires the "whole" insulative layer to **comprise** $(\text{CH}_3)_x\text{SiO}_y$ which does not require the whole layer to **be** $(\text{CH}_3)_x\text{SiO}_y$. Note that the plasma exposure time is 10 minutes.

To quote from **Morita** at page 5,

"When this semiconductor substrate **1** is exposed to an **oxygen plasma** for ten minutes, the **organic functional groups** of **organic** silicon thin film **10** **are removed** to a desired depth, transforming into a silicon oxide film. As such, the film thickness of organic silicon thin film **10** as initially formed, in its thinnest portions, transforms **nearly** entirely to silicon oxide film **11**; only in the thickest portion does it come so as to have **a two-layer structure of silicon oxide film 11 and organic film 10** (figure 3)." (Emphasis added; page 5 of translation, lines 5-14).

Morita teaches that the oxygen plasma treatment solves the problem of poor insulation of the upper portion of organic spin-on glasses by removing the excess organic moieties at the surface, while beneficially preserving adhesion to the underlying layers by leaving the organic moieties in the lower portion of the film. The **Morita** exposure is indicated not to etch but, instead, only to remove a portion of the organic material in the surface of the deposited layer. (See translation provided by Applicant, section entitled "FUNCTION" beginning on p. 3.) While it is noted that a 10-minute exposure converts the thinnest portions of the insulative layer to silicon dioxide, the plasma exposure is still "**effective** to allow a base chemistry of the whole deposited first layer to

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remain substantially without transformation” since (1) no requisite is provided for “substantially;” and (2) since as noted above in the rejection of the claims under 35 USC 112(2), there exists no requirement for this step to even occur, as it is not positively recited to occur.

Accordingly, it would have been obvious for one of ordinary skill in the art, at the time of the invention to modify **Yau** to carry out the plasma treatment in **Morita** for the reasons just indicated in **Morita** for carrying out the plasma treatment. As indicated the dielectric would inherently be lowered because Applicant indicates that an oxygen plasma treatment will lower the dielectric constant. This makes common sense since the organic portion removed will leave behind additional porosity in the **Yau** dielectric layer, and space has the lowest dielectric constant attainable thereby lowering the overall dielectric constant of the layer.

Regarding claim 103, **Yau** discloses O_2 and N_2O and any oxygen containing gas, as noted above.

Regarding claims 104, 105 as noted above, **Morita** teaches oxygen which is not water and is therefore, dry oxygen.

Regarding claim 106-108, **Yau** discloses nitrous oxide, N_2O .

Regarding claim 109, **Yau** discloses methyl silane and N_2O deposition, and **Yau** teaches oxygen plasma exposure.

Regarding claim 110, the stability of the dielectric layer is inherently increased for the reasons indicated in **Morita** and by Applicant.

Regarding claim 112, **Morita** teaches that the organic silicon film is cured at 450 °C and no heating appears to be indicated; therefore, the temperature during exposure must be less than 550 °C.

Regarding claims 115, 122, 123, and 130, both **Yau** and **Morita** make the film from at least methylsilane. **Yau** specifically indicates that the film has from 1-50% carbon arising from Si-C bonds, preferably 20%. (col. 5, lines 12-44). Furthermore, Applicant has not indicated any criticality to the claimed portions. See In re Hoeschele, 406 F.2d 1403, 160 USPQ 809 (CCPA 1969) (Claimed elastomeric polyurethanes which fell within the broad scope of the references were held to be unpatentable thereover because, among other reasons, there was *no evidence of the criticality* of the claimed ranges of molecular weight or molar proportions.). Any difference is a matter of routine optimization within prior art general conditions. (See MPEP 2144.05.)

Regarding claim 116, **Morita**, as noted above indicates that the exposure the organo dielectric leaves the organo dielectric substantially as its original composition. Since **Yau** teaches Applicant's specific method of deposition using Applicant's claimed methylsilane, the deposited film is $(\text{CH}_3)_x\text{SiO}_y$, which would stay "substantially as $(\text{CH}_3)_x\text{SiO}_y$ " according to the teachings in **Yau** and by Applicant.

Regarding claims 117-121, although the time is not exactly as claimed by Applicant, it has been held that claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art. See In re Huang, 40 USPQ2d 1685, 1688(Fed. Cir. 1996). In the instant case, there exists no evidence of record to indicate that some unexpected result arises from the claimed time range relative to that in the applied art. It would have been obvious for one of ordinary skill in the art, at the time of the invention to use a shorter exposure time than in **Morita** since the dielectric layer formed by **Yau** is already porous and oxidized by the method of deposition rather than being a solid mass formed by a spin-on

technique. The choice of exact time is an obvious matter of routine optimization to provide the best dielectric layer with the lowest reasonable dielectric constant.

Regarding claim 124 and 131, as noted above, the insulative layer may be an interlayer dielectric.

Regarding claims 126-128, 133, and 134, the **Yau** deposited dielectric layer is deposited with a dielectric constant of 2.5, as noted above. It is held absent evidence to the contrary that the dielectric constant is reduced by at least 10% or about 15% by exposure to the oxygen plasma and that the dielectric constant is inherently stabilized. If it is thought for some reason that the dielectric constant is not reduced or is not stabilized by exposure to the oxygen plasma, then these may be a difference. But, it has been held, where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that subject matter shown to be in the prior art does not possess the characteristics relied on. (See MPEP 2112.) Given the similarity (if not equality) of the dielectric materials formed, the present evidence indicates that the dielectric constant must necessarily be reduced and stabilized.

8. Claim 111 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Yau** in view of **Morita**, as applied to claims 102-110, 112, 115-124, 126-128 above, and in further view of **Miyasaka** (US 6,017,779).

The prior art as explained above discloses all of the limitations of the claimed invention except for (1) depositing the $(\text{CH}_3)_x\text{SiO}_y$ layer and exposing in the same chamber is not taught

(Applicant's claims 8 and 34); and (2) shutting off the silicon process gas and maintaining conditions in the chamber to expose the dielectric to the oxygen plasma is not taught (Applicant's claim 35).

Miyasaka teaches a method of forming a silicon oxide layer on a semiconductor device using plasma-enhanced CVD with silicon-containing compound and a oxygen-containing gas and then shutting off the silicon-containing precursor and then exposing to the oxygen plasma in the same chamber maintained at sub-atmospheric pressure. (See **Miyasaka**, column 44, "Example 6" especially lines 35-52.)

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify either of **Yau** in view of **Morita** to maintain a device in a single chamber as taught by **Miyasaka** in order to beneficially prevent contamination to the semiconductor device dielectric layer between process steps, as is well known in the art to do, and furthermore, because it would simplify the process dramatically by preventing a switch in chambers.

Response to Arguments

9. Applicant's arguments filed 30 September 2003 have been fully considered but they are not persuasive.

In response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., the plasma exposure being "effective to allow a base chemistry of the whole deposited first layer to remain substantially without transformation to another base chemistry") are not **required** in the rejected claim(s) because **the step is not positively recited so as to require such conversion to occur in**

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the first place. Additionally there exists no requisite is provided for “substantially” in the claims and the specification does not provided an explicit definition for the term “substantially.” Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

Further in this regard, independent claim 129 states that “the whole insulative layer **comprises** $(\text{CH}_3)_x\text{SiO}_y$,” which does not require the **whole** layer to **be** $(\text{CH}_3)_x\text{SiO}_y$, but only to **include** $(\text{CH}_3)_x\text{SiO}_y$. Thus the combination of Yau with Morita teaches this feature, as noted above in the rejection.

The combination is proper for reasons of record. there exists no frustration of the Morita invention. Moreover, Morita is not the base reference and does not teach away from the benefit of applying the oxygen plasma exposure to the Yau insulative layer to provide a more stable and better adhered insulative film.

Conclusion

10. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period

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will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 703-306-5980. On or about 5 February 2004, this number will change to 571-272-1693. The examiner can normally be reached on 9:00 - 19:30 on Monday through Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr., can be reached at 703-308-4940 (new telephone number will be 571-272-1702). The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.



Erik Kielin
Primary Examiner
January 29, 2004